A Study of the Impact of Ammonia Injection On Marketable Fly Ash Including Quality Control Procedures

Russ K. Majors
Boral Material Technologies Inc. 45 N.E. Loop 410 # 700 San Antonio, TX 78216 (210) 349-4069

Dr. Russell Hill
Boral Material Technologies Inc. 45 N.E. Loop 410 # 700 San Antonio, TX 78216 (210) 349-4069

Robert McMurry
Duke Energy Mail Code EC12ZB 526 S. Church St. Charlotte, NC 28202(704) 373-7899

Scott Thomas
Duke Energy Belews Creek Station P.O. Box 557 Walnut Cove, NC 27052(336) 427-0274

Abstract

In the summer of 1997, the Belews Creek Steam Station, owned and operated by Duke Energy in North Carolina, initiated the use of ammonia in their process. This had a profound impact on the sales quality of the fly ash. A cooperative program was established between Duke Energy and Boral Material Technologies Inc. to determine if a marketable fly ash could still be produced. BMTI developed a QC testing program and established threshold values for the ammonia in sales grade ash. Through the implementation of this program and the vital feedback of multiple daily ammonia levels, efforts were made to maximize the efficiency of the injection system so that excessive amounts of ammonium sulfate salts would not be deposited on the ash.

Introduction

Ammonia is used at coal burning power-generating stations to reduce particulate emission or to reduce NO_x levels. Particulate reduction from the electrostatic precipitator is enhanced through the combined use of ammonia and SO_3 conditioning. Selective Catalytic Reduction (SCR) and Selective Non-Catalytic Reduction (SNCR) are post combustion NO_x controls that use ammonia as the reducing agent. It is anticipated the use of these technologies will increase due to the additional NO_x reduction that will be required because of the stringent new ozone standard and the EPA SIP call to address long range transport of ozone.

In both applications, whether intentional or not, ammonia is deposited on the fly ash. These ammonium sulfate compounds are quite stable until they are introduced into an aqueous environment having a high pH. In this environment, ammonia is driven out of solution in the form of a gas. This high pH, highly alkaline environment precisely describes concrete, the primary market in which fly ash is used.

An investigative group was formed with members from both Duke Energy and Boral Material Technologies Inc. The objective of this group was to perform a literature search, implement tests, and

monitor the levels of ammonia in the fly ash to determine if the efficiency of the process using ammonia could be improved upon resulting in lower ammonia levels in the fly ash.

Experimental

The investigative group set out to address several issues concerning the use of ammoniated fly ash. These include:

1. Ammonium sulfate distribution on fly ash
2. Development of QC procedures
3. Impact of ammoniated fly ash on the physical characteristics of concrete
4. Health risk of ammonia during the placement of concrete containing ammoniated fly ash

The distribution of precipitated ammonium sulfate compounds in fly ash was affected by particle size. Lower ammonia concentrations were found in the inlet hoppers of the electrostatic precipitator. The inlet fields typically collect the majority of the ash that is primarily comprised of larger ash particles. The finer ash collected in the outlet hoppers had a much higher concentration of ammonia.

Initial determinations of ammonia levels in fly ash were performed by independent analytical laboratories. Although these tests results were accurate and reproducible, a field test was needed to provide more timely information about the quantity of ammonia in fly ash. A simple yet effective test for ammonia was developed which centered on detector tubes commonly used for air quality analysis. There are several limitations to the test, however, if performed consistently, the results correlate well with results obtained through analytical laboratories. This test is used on a day to day basis for the implementation of the ammonia quality control program at Belews Creek.

A principle concern of the use of ammoniated fly ash in concrete is its contribution to changes in any physical parameters like set time, strengths, flow, etc. An investigation by EPRI[1] indicated that no appreciable changes could be detected in the physical characteristics of concrete which utilized ammoniated fly ash as compared to fly ash without ammonia which was verified independently using ammoniated ash from Belews Creek.

An ongoing objective of the research group is to determine the “human” impact of ammoniated fly ash. Olfactory detection of ammonia can be as low as 5 parts per million. To further complicate matters, the degree of offgassing of ammonia can be affected by temperature, humidity, and elapsed time. This changes the impact of the offgassed ammonia on human perception especially when comparing winter to summer and indoor vs. outdoor applications of concrete with ammoniated fly ash. As a result of feedback from the field and information from EPRI’s report, ammonia limits were set for salable ash. In general, injection rates of ammonia of less than 3 ppm resulted in concentrations on the fly ash that did not significantly impact fly ash sales. When injection rates exceed this level close attention is given to how and where this ash is used. These limits are subject to further refinement as more information from the field is assimilated.

Conclusion

There is a tremendous need for research in the use of ammoniated fly ash. If utilities are to achieve significantly lower NO_x levels, then there is no doubt that many units will have to start turning to SCR and SNCR type technologies. Standard field tests must be established to monitor the ammonia levels in ash and maximum allowable limits must also be established. To accomplish these tasks will require contributions from utilities, ash marketers, ready mix concrete suppliers, and concrete finishers. Feedback of information from the field is critical. It allows the ash marketer to set practical limits for the allowable ammonia in sales grade ash. Research may prove new applications of existing technologies to be feasible for eliminating ammonia in fly ash. The use of ammonia to accomplish either lower particulate levels or NO_x levels will certainly contribute to better air quality. However, this must be tempered with research allowing the continued transport of fly ash into markets thereby extending the serviceable lifetime of current landfills and possibly eliminating the need for future landfill sites.

[1] EPRI TR-106747-V1 3176-17 November 96 "Assessment of Impacts of NO_x Reduction Technologies on Coal Ash Use"